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THE RISE OF TEMPERATURE ASSOCIATED WITH THE MELTING OF ICEBERGS.

[By H. T. BARNES, F. R. S., McGill University, Montreal, Canada. Reprint from *Nature*, December, 1912.]

In a letter to *Nature* published in the issue of December 1, 1910, I showed by means of microthermograms taken on a trip to Hudson's Straits that an iceberg melting in salt water produces a rise of temperature. The experiments were performed on the Canadian Government

steamship *Stanley*, and indicated that when approaching ice a rise of temperature occurred followed by a rapid fall of temperature a quarter of a mile abeam of the berg.

During the past summer I had an opportunity of examining in detail the temperature effects of icebergs. The Canadian Government placed its steamship *Montcalm* at my disposal for the tests, and three weeks were spent through the Straits of Belle Isle. Careful records were made of the temperature effects of icebergs and land. These tests have shown conclusively that it is the rise of temperature which is the direct action of the melting iceberg, and that when a fall of temperature is observed near ice it is due to the action of a colder current in which the iceberg is floating, and is not due to the cooling influence of the ice. Cooler currents may exist

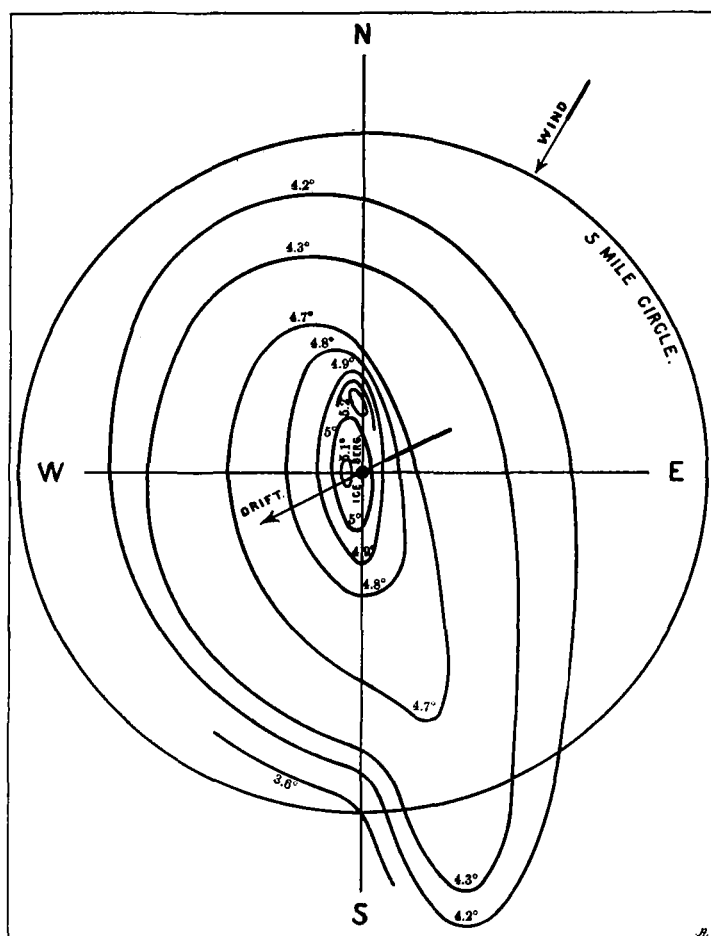


FIG. 1.—Isothermal lines around an iceberg.

throughout the Arctic current whether accompanied by ice or not, but the presence of the ice causes a zone of warmer water to accumulate for a considerable distance about it.

The icebergs I studied in the Straits of Belle Isle and off the eastern end of the straits in the Labrador current showed no appreciable cooling even within a few yards of them. The rise of temperature approaching an isolated berg was somewhat over 2°C . In figure 1, I show the isothermal lines about a typical berg off the eastern entrance to the Straits of Belle Isle. This diagram was obtained by arranging a number of courses for the ship from all sides up to a radius of 6 miles.

As a good example of how icebergs and groups of icebergs affect the water temperature, I show a microthermogram in figure 2 taken from the records made passing

westward through the Straits of Belle Isle. In every case the approach to ice caused a rise of temperature.

The explanation of this effect which I gave at my Friday evening discourse at the Royal Institution last May was founded on Pettersson's theory of ice melting in salt water. By this theory, which can easily be verified by a simple experiment, ice melting in salt water

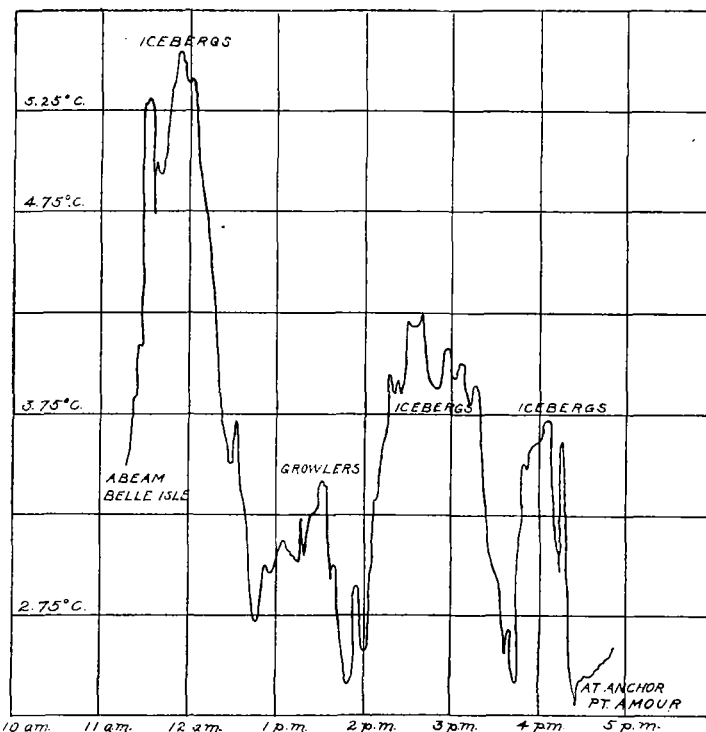


FIG. 2.—Microthermogram through the Straits of Belle Isle, showing effect of ice on the temperature of the water.

produces three currents: (1) A current of salt water cooled by the ice which sinks downward by gravity; (2) a current of warm salt water flowing toward the ice; (3) a current of light fresh water from the ice rising and spreading out over the surface of the salt water.

I at first thought that it was this surface current of fresh water that influenced the microthermometer. The fringe of this lighter water would be lighter than the sea

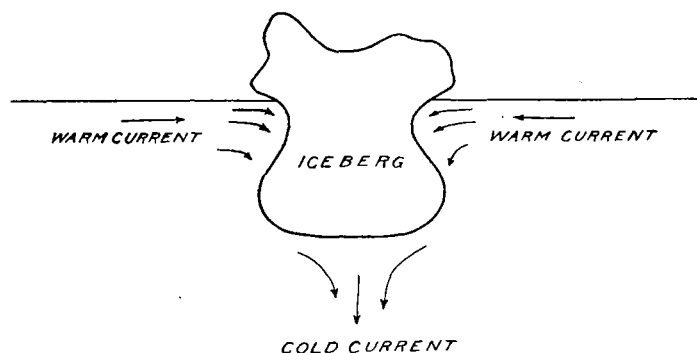


FIG. 3.—Currents set up by a slowly melting iceberg in salt water.

water on account of the action of the sun and scattered radiation which is very strong at sea. The lighter water would retain the heat because it could not mix readily with the sea water. Near the iceberg I considered that a fall of temperature would result from the cooling influence of the surface current of fresher water.

My recent tests have shown, however, that an iceberg melts so slowly that no effect of the dilution can be

detected even right beside the berg. I took a number of samples of sea water at different distances from the icebergs, as well as samples taken far from ice. These samples I carefully bottled and brought home to the laboratory, where they were most accurately tested for me by the electric conductivity method in the physico-chemical department by Dr. McIntosh and Mr. Otto Maass. No possible error could result in this way, and the tests being carried out at a constant temperature under the most favorable conditions, there is no reason to doubt their correctness. The comparison shows no dilution due to the icebergs, which goes to show how quickly the melted water from the berg is mixed with the sea water. Larger variations were found at different parts of the sea than were obtained in the proximity of ice.

It is evident that an iceberg in melting produces only two of the Pettersson currents, i. e., a cold current which sinks downward carrying with it all the melted ice water, and a horizontal surface current of sea water flowing in toward the ice to cause its melting. By this means we should expect the sea in the immediate proximity of icebergs to be warmer than farther away, because the sea surface current is moving inward to the berg and does not share in the normal vertical circulation which tends to keep the sea surface temperature cooler.

An iceberg in causing its own current of warmer water provides for its own disintegration. Abundant evidence is at hand to show the melting process going on under the water line.

In my observations of icebergs I was greatly struck with the large amount of air dissolved in the ice. The white color of the berg is due to innumerable air bubbles in the ice, and not to snow on the surface. An iceberg is very deceptive in this way. While it looks quite soft, the ice is so hard as to make it difficult to chop it with an axe. Ice water which I prepared for drinking on board ship with iceberg ice appeared to effervesce like soda water, merely due to the liberation of the air from the melting ice. It is possible that the sudden disappearance of bergs with a loud report is due to their explosion from accumulated air in their interior. I passed close to one berg which was casting off small pieces, apparently by the pressure of the pent-up air.

While icebergs send the temperature of the sea up, land and the coast line send it down. This was observed all along the coast in the Straits of Belle Isle. This effect is due to the action of the land in turning up the colder underwater by the action of tides and currents. A great deal of work remains to be done in studying the effect of land and shoals on the temperature of the sea, but observations show the effect not only here, but on the Irish and English coasts.

From the point of view of the safety of the St. Lawrence route the effect of land is most important. The iceberg causes us little worry because we have only a very short ice track, but to find means whereby the proximity of land can be determined is of the greatest importance.

FRAZIL AND ANCHOR ICE DISSIPATED BY A SIMPLE REMEDY.

The importance of keeping water and turbine wheels free from ice, so that work may not be interrupted in large factories, has led Dr. Howard T. Barnes, professor of physics at McGill University, Montreal, Canada, to study the method of formation of frazil and anchor ice with the view to finding some remedy for the many annoyances that

it causes in the cold winters of Canada (and to a less degree in many parts of the United States). It has long been recognized that the rising sun brings speedy relief to hydraulic plants that are frozen up with frazil. Experience had also shown that water wheels protected by wooden racks were better able to withstand frazil than those protected by iron racks. The fact is that the water when just at the freezing point needs only to be cooled the hundredth or the thousandth part of a degree Fahrenheit in order to turn into hard ice and that, too, in a very few minutes. Vice versa, when machinery is frozen up in frazil the latter will quickly turn back to water by the application of a little heat in the form of steam if properly turned on. By waiting several hours the ice may become as hard as stone, but the prompt application of steam will work marvels.

The St. Lawrence River water remains just at the freezing point nearly all winter wherever it is flowing rapidly, but it makes frazil in quiet places and after sunset, or above such a waterfall as Lachine Rapids. On the other hand, warmth of sunlight or the warmth produced by descending rapids is sufficient to dissipate the frazil, although the change in temperature is only a few thousandths of a degree. A very small boiler of water and a ton of coal will generate enough steam, if led by pipe to the water that is about to enter a turbine, to give the water the slight additional warmth necessary to protect it from frazil.

Mr. John Murphy, engineer of the Ottawa Electric Railway Co., says that they have had no trouble with frazil since applying this remedy in 1907. Of course many special patents have been issued relative to this new idea of warming the water to prevent frazil and anchor ice being formed in the cold water. The economy consists in the fact that by prompt action we prevent the formation, rather than wait a few hours until the ice becomes very hard, cold, and thick, therefore requiring an almost impracticable amount of heat. It is only during the few seconds required by the water to flow through the turbine or over the wheel that we need to heat the liquid and prevent the ice.

C. A.

THE STORMS OF NOVEMBER IN JAMAICA, WEST INDIES.

The Hon. Maxwell Hall, Esq., of Montego Bay, well known as one of the most learned men of the West Indies, and as an active astronomer, jurist, and meteorologist, the founder and director of the present system of meteorology on that island, has sent us a preliminary report on the storms and hurricanes of November, 1912, from which we make only the following abstracts, as he hopes to prepare a full report, with maps, showing the condition of the atmosphere for every two hours during the progress of the storms.

In connection with the worst of the hurricane which was at 6 p. m., November 18, at Kempshot, he says:

There was a most brilliant yellow light all over the confused sky and all around the horizon; it changed to orange, then to red, then clouded over with dark squalls, and suddenly the northwest hurricane of 120 miles per hour was down upon us. The light was seen all over the west end of the island and caused some alarm. At Falmouth it was seen at nighttime. When I first saw it we were just emerging from the central calm area 20 miles in diameter.

In his general account of the three several storms of the month, Mr. Hall says:

Heavy rains fell over the northeastern part of the island in the shires of St. Thomas, Portland, St. Andrew, and St. Mary, on the 10th, 11th, and 12th of November, 1912. On these three days 34 inches fell at Rose Hill near Hardware Gap in St. Andrew's Parish, and 36 inches fell in Moy Hall near Cedar Valley in St. Thomas Parish. These rains produced